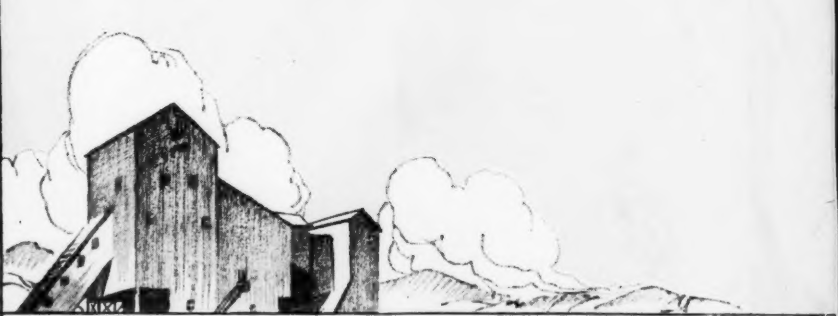
The CRUSHED STONE JOURNAL

In This Issue



January — March · 1940

Official Publication
NATIONAL CRUSHED STONE ASSOCIATION

Technical Publications

of the

National Crushed Stone Association, Inc.

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BULLETIN No. 1

The Bulking of Sand and Its Effect on Concrete

BULLETIN No. 2

Low Cost Improvement of Earth Roads with Crushed Stone

BULLETIN No. 3

The Water-Ratio Specification for Concrete and Its Limitations

BULLETIN No. 4

"Retreading" Our Highways

BULLETIN No. 5

Reprint of "Comparative Tests of Crushed Stone and Gravel Concrete in New Jersey" with Discussion

BULLETIN No. 6

The Bituminous Macadam Pavement

BULLETIN No. 7

Investigations in the Proportioning of Concrete for Highways

BULLETIN No. 8

The Effect of Transportation Methods and Costs on the Crushed Stone, Sand and Gravel, and Slag Industries

BULLETIN No. 9

Tests for the Traffic Durability of Bituminous Pavements

BULLETIN No. 10

Stone Sand

Single copies of the above bulletins are available upon request.

Manual of Uniform Cost Accounting Principles and Procedure for the Crushed Stone Industry ($2.00 per copy)

The Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

J. R. BOYD, Editor

Contents

J. A. RIGG

Manager, Acme Limestone Company, Fort Spring, W. Va., who was elected President of the National Crushed Stone Association at its recent Twenty-Third Annual Convention held in St. Louis, Mo.

THE
CRUSHED STONE JOURNAL
WASHINGTON, D. C.
Vol. XV No. 1 JANUARY—MARCH, 1940

Highlights of the Twenty-Third Annual Convention

• Registration exceeds four hundred. J. A. Rigg elected President. Fred Braun becomes Chairman of Manufacturers' Division.

THE Twenty-Third Annual Convention of the National Crushed Stone Association held at the Jefferson Hotel, St. Louis, Missouri, on January 22, 23 and 24, need make no apologies to its twenty-two predecessors. Judging from the constantly evidenced enthusiasm of the four hundred odd delegates in attendance, it should be rated as one of the best held in the history of the Association. To a degree certainly not realized for many years, the program commanded exceptional interest as indicated by the prompt and sustained attendance at sessions and more especially by the general discussion which followed the presentation of many of the papers. Those charged with the responsibility for program development particularly noted the obvious interest in discussions dealing with operating problems. Talks of this character will be given a prominent place on the program for the 1941 meeting. In this connection it would be especially helpful if members of the Association would write us concerning their ideas as to timely operating problems which might be appropriately included on next year's program.

Various social activities scheduled during the three-day convention period, proved a highly acceptable supplement to the serious side of the meeting and gave to most of those present the only opportunity during the year to fraternize in a spirit of relaxation and enjoyment with fellow producers from all sections of the country.

The Manufacturers' Division Exposition of machinery and equipment utilized in the production of crushed stone maintained its well deserved reputation as one of the outstanding features of the Convention. Participated in by forty exhibitors occupying fifty-seven booths, the Exposition received constant attention throughout the Convention. This represents some improvement over last year when we had thirty-eight exhibitors occupying fifty-three booths.

Immediately prior to the Exposition, crushed stone producers and manufacturers of machinery and equipment were brought together at a reception followed by a buffet supper, thus giving equipment manufacturers and producers an excellent opportunity to become better acquainted before the formal opening of the Exposition. Ample opportunity was provided throughout the Convention period for inspection of the Exposition, with all of Tuesday afternoon devoted solely to this purpose. We are convinced that those who carefully studied the exhibits must have obtained a wealth of information as to recent developments and improvements in the machinery and equipment utilized by the industry.

We are especially indebted to Mr. L. W. Shugg of the General Electric Company for the commendable manner in which he handled his difficult responsibilities as Director of Exhibits and our grateful appreciation is extended to the General Electric Company for its courtesy in permitting Mr. Shugg to serve us in that capacity. In order to arrive in St. Louis in time to handle our Exposition arrangements, Mr. Shugg had to make a combination air and rail trip to St. Louis part of which was accomplished under unfavorable weather conditions and at very

real personal inconvenience. Notwithstanding this handicap, he arrived at the appointed time and we wish him to know how much we appreciate his valuable cooperation.

J. A. Rigg Elected President

At the business session of the Convention held on Wednesday afternoon, Mr. J. A. Rigg, Acme Limestone Co., Fort Spring, West Virginia, was unanimously elected President of the Association for the ensuing year. The election of Mr. Rigg to this important post is certain to meet with universal favor as not only is he highly regarded throughout the industry, but is well deserving of this honor in view of his long and enthusiastic support of Association objectives. In placing Mr. Rigg's name in nomination for the Presidency, Mr. Rarey, Chairman of the Nominating Committee, spoke as follows:

"Two years ago it was my very great pleasure to nominate, on behalf of the Nominating Committee, for your consideration as President of this Association one Southern gentleman to succeed another Southern gentleman, Mr. Weston succeeding Mr. Rodes.

"At the risk of seeming to stereotype our action in this respect, I again find myself in a similar position. The man whose name I offer on behalf of the Nominating Committee for President of the Association is a very sincere believer in and supporter of the activities of the Association. I hope and believe that you will share with me the pleasure I have in offering to you the name of J. A. Rigg of West Virginia as President for the ensuing year."

L. W. Shugg
General Electric Co.
Director of Exhibits

Mr. Rigg after being unanimously elected was escorted to the Chair by Past Presidents Otho M. Graves and Russell Rarey. In accepting the Presidency Mr. Rigg spoke as follows:

"Gentlemen, I say in all sincerity I don't see why you have conferred upon me the highest honor that this fine group of men has to offer. My emotional makeup does not permit me to say anything more in that respect.

"A number of years ago (I will not say how long) I came to my first meeting of this Association held in Cincinnati. I found that the Association at that time was still, I might say, in its swaddling clothes. At that meeting I heard a young man enthusiastically outline the possibilities of this Association and give his concept of how those possibilities might be materialized. The man to whom I refer is Mr. Graves. At the conclusion of that Convention I became a member. I would like you to note that particular point. I have attended every annual gathering of this body since then, but one. Just what detained me at that time, I can't at this moment recall, but I am sure it was something of an urgent nature.

"I have seen the possibilities outlined by Mr. Graves at that time, and others which have developed since, materialize under his able leadership and the capable men that this Association has selected to lead it from time to time until the retirement of Mr. Weston today. I have seen our Washington office established and our Bureau of Engineering grow. Because of this leadership and the activities of Mr. Boyd and Mr. Goldbeck, I have seen this Association grow to an influence in the industrial construction and engineering fields far beyond what might have been expected. I am proud that I am a member of this Association, and always have been proud of it.

"Today I accept this honor in pride and, paradoxically, in humility. No man can have an honor like this conferred upon him and not be proud of it. I accept it in humility, feeling my utter inadequacy at this time to fulfill the high expectations that you have a right to anticipate, especially when I compare myself with the men whom you have previously placed in this high position. But I pledge you, gentlemen, that I will do everything I can to live up to the duties of this office, so far as my capacity will permit."

In grateful and sincere appreciation for the capable and sympathetic service rendered by Mr. Weston while serving the Association for two years as President, the following resolution was unanimously adopted by rising vote:

"To our retiring President, Mr. T. I. Weston, who leaves that office as he came to it, with the respect and affection of all the members of this Association, we tender our sincere thanks for his valued service to the Association and our warm congratulations upon the vista of happiness that the future so charmingly presents to him."

Again as the final act of the Convention all delegates arose and enthusiastically applauded the retiring President, a further tribute which he graciously acknowledged.

Recommendations of the Nominating Committee as to Regional Vice-Presidents and members of the

Board of Directors were unanimously approved by the Convention and resulted in the election of the following:

REGIONAL VICE-PRESIDENTS

Eastern—W. M. Andrews, New Castle, Pa.
Central—W. C. Sparks, Princeton, Ky.
Southeastern—W. T. Ragland, Raleigh, N. C.
Southwestern—R. S. Wilson, Little Rock, Ark.
Northern—A. J. Cayia, Manistique, Mich.
Northwestern—Porter W. Yett, Portland, Ore.
Western—A. J. Wilson, Watsonville, Calif.
Midwestern—N. E. Kelb, Indianapolis, Ind.

BOARD OF DIRECTORS

Chairman—J. A. Rigg, Acme Limestone Co., Fort Spring, W. Va.
W. M. Andrews, Union Limestone Co., New Castle, Pa.
C. C. Beam, C. C. Beam, Inc., Melvin, Ohio
W. P. Beinhorn, Trap Rock Co., Minneapolis, Minn.
H. E. Billman, Rock Hill Stone and Gravel Co., St. Louis, Mo.
L. J. Boxley, Blue Ridge Stone Co., Roanoke, Va.
*Fred Braun, W. S. Tyler Co., Cleveland, Ohio
Harold R. Brownson, Rowe Contracting Co., Malden, Mass.
J. Reid Callanan, Callanan Road Improvement Co., South Bethlehem, N. Y.
A. J. Cayia, Inland Lime and Stone Co., Manistique, Mich.
A. R. Couchman, North American Cement Corp., New York City
C. M. Doolittle, Canada Crushed Stone Corp., Hamilton, Ont., Canada
F. O. Farnshaw, Carbon Limestone Co., Youngstown, Ohio
Arthur F. Eggleston, John S. Lane and Son, Inc., Meriden, Conn.
Otho M. Graves, General Crushed Stone Co., Easton, Pa.
A. Acton Hall, Ohio Marble Co., Piqua, Ohio
George Hammerschmidt, Elmhurst-Chicago Stone Co., Elmhurst, Ill.
T. Ward Havely, Central Rock Co., Lexington, Ky.
J. L. Heimlich, LeRoy Lime and Crushed Stone Co., LeRoy, N. Y.
R. P. Immel, American Limestone Co., Knoxville, Tenn.
N. E. Kelb, Ohio and Indiana Stone Co., Indianapolis, Ind.
E. J. Krause, Columbia Quarry Co., St. Louis, Mo.
J. D. Lane, Raleigh Granite Co., Raleigh, N. C.
Paul M. Nauman, Dubuque Stone Products Co., Dubuque, Iowa
W. T. Ragland, Superior Stone Co., Raleigh, N. C.
H. E. Rainer, Federal Crushed Stone Corp., Buffalo, N. Y.
Russell Rarey, Marble Cliff Quarries Co., Columbus, Ohio
John Rice, General Crushed Stone Co., Easton, Pa.
H. E. Rodes, Franklin Limestone Co., Nashville, Tenn.
Dan Sanborn, Lehigh Stone Co., Kankakee, Ill.
James Savage, Buffalo Crushed Stone Co., Buffalo, N. Y.
F. W. Schmidt, Jr., North Jersey Quarry Co., Morristown, N. J.

WM. E. HILLIARD
New Haven Trap Rock Co., Reelected Treasurer at the 23rd Annual Convention

*L. W. Shugg, General Electric Co., Schenectady, N. Y.
W. C. Sparks, Cedar Bluff Quarry, Princeton, Ky.
O. M. Stull, Liberty Limestone Corp., Rocky Point, Va.
Stirling Tomkins, New York Trap Rock Corp., New York City
W. H. Wallace, Wallace Stone Co., Bay Port, Mich.
T. I. Weston, Weston and Brooker Co., Columbia, S. C.
Harold Williams, Boston, Mass.
*Roy Wills, Lima Locomotive Works, Inc., Lima, Ohio
A. J. Wilson, Granite Rock Co., Watsonville, Calif.
R. S. Wilson, Big Rock Stone and Material Co., Little Rock, Ark.
W. F. Wise, Southwest Stone Co., Dallas, Texas
A. L. Worthen, New Haven Trap Rock Co., New Haven, Conn.
Porter W. Yett, City Motor Trucking Co., Portland, Ore.

At the meeting of the newly elected Board of Directors held on Thursday morning following the Convention, William E. Hilliard, New Haven Trap Rock Company, New Haven, Conn., Treasurer of the Association, A. T. Goldbeck, Engineering Director and J. R. Boyd, Administrative Director, were reelected. Also, at the same meeting of the Board of

*Representing the Manufacturers' Division on the Board of Directors of the National Crushed Stone Association.

Executive Committee

Executive Committee of the National Crushed Stone Association elected by the Board of Directors at its meeting in St. Louis on January 25, 1940

OTHO M. GRAVES
General Crushed Stone Co., Easton, Pa.

N. E. KELB
Ohio and Indiana Stone Co., Indianapolis, Ind.

J. A. RIGG, *Chairman*
Acme Limestone Co.
Fort Spring, W. Va.

E. J. KRAUSE
Columbia Quarry Co., St. Louis, Mo.

RUSSELL RAREY
Marble Cliff Quarries Co., Columbus, Ohio

STIRLING TOMKINS
New York Trap Rock Corp., New York City

T. I. WESTON
Weston and Brooker Co., Columbia, S. C.

A. L. WORTHEN
New Haven Trap Rock Co., New Haven, Conn.

Directors the following were elected to serve on the Executive Committee for the ensuing year:

J. A. Rigg, *Chairman*	Russell Rarey
Otho M. Graves	Stirling Tomkins
N. E. Kelb	T. I. Weston
E. J. Krause	A. L. Worthen

FRED BRAUN ELECTED CHAIRMAN OF MANUFACTURERS' DIVISION

At the annunal business meeting of the Manufacturers' Division held during the convention period, Fred Braun of the W. S. Tyler Company, Cleveland, Ohio, was elected Chairman of the Manufacturers' Division. For many years Mr. Braun has been actively identified with the affairs of the Division and because of his wide experience and pleasing personality is certain to handle the responsibilities of this office in a commendable manner.

FRED BRAUN
Newly elected Chairman, Manufacturers Division

Upon the retirement of Mr. Roy Wills as Chairman for the past year, the Manufacturers' Division in appropriate resolution, expressed its sincere appreciation for the time and effort he expended in capably directing the affairs of the Division during the past year.

The following Vice-Chairmen and members of the Board of Directors were also elected:

VICE-CHAIRMEN

W. M. Black, American Manganese Steel Division of the American Brake Shoe and Foundry Co., Chicago Heights, Ill.

F. E. Finch, Hardinge Co., York, Pa.

J. Harper Fulkerson, Cross Engineering Co., Carbondale, Pa.

E. J. Goes, Koehring Co., Milwaukee, Wis.

Frank B. Ungar, Ludlow-Saylor Wire Co., St. Louis, Mo.

BOARD OF DIRECTORS

Fred Braun, Chairman, The W. S. Tyler Co., Cleveland, Ohio.

W. M. Black, American Manganese Steel Division of the American Brake Shoe and Foundry Co., Chicago Heights, Ill.

M. A. Eiben, Northern Blower Co., Cleveland, Ohio.

F. E. Finch, Hardinge Co., York, Pa.

A. E. Forster, Hercules Powder Co., Wilmington, Del.

J. Harper Fulkerson, Cross Engineering Co., Carbondale, Pa.

E. J. Goes, Koehring Co., Milwaukee, Wis.

H. T. Gracely, Marion Steam Shovel Co., Marion, Ohio.

C. S. Huntington, Link-Belt Co., Chicago, Ill.

Kenneth Jensen, Kensington Steel Co., Chicago, Ill.

H. A. Johann, Frog, Switch & Mfg. Co., St. Louis, Mo.

F. O. Reedy, Kennedy-Van Saun Mfg. & Eng. Co., New York Ctiy.

S. R. Russell, E. I. duPont de Nemours & Co., Wilmington, Del.

Bruce G. Shotten, Hendrick Mfg. Co., Pittsburgh, Pa.

L. W. Shugg, Genueral Electric Co., Schenectady, N. Y.

John Swenehart, Atlas Powder Co., Wilmington, Del.

P. C. Tennant, The Texas Co., New York City

S. W. Traylor, Traylor Eng. & Mfg. Co., Allentown, Pa.

Frank B. Ungar, Ludlow-Saylor Wire Co., St. Louis, Mo.

Roy Wills, Lima Locomotive Works, Lima Ohio.

F. O. Wyse, Bucyrus-Erie Co., South Milwaukee, Wis.

The Annual Banquet

The Gold Room of the Hotel Jefferson formed an attractive setting for the Twenty-Third Annual Banquet of the Association held on Tuesday evening. Immediately prior to the Banquet, the customary reception was held for all those in attendance at the Convention.

The Banquet was by far the largest held in recent years, with a program which seemed to prove especially appealing. After appropriate opening remarks by President Weston, officiating as Toastmaster, the presentation of awards for the 1938 National Crushed Stone Association Safety Contest was made by William H. Cameron, Managing Director of the National Safety Council. As was to be expected, Mr. Cameron discharged his responsibilities in a highly commendable manner. After giving a stimulating and interesting discussion concerning the broader aspects of the safety movement, he asked each of the companies winning distinction in the contest to send forward a representative to receive its award and it was gratifying to note how

many companies had representatives present. The principal address of the evening was given by Dr. Allen A. Stockdale. Dr. Stockdale speaking on the subject of "Free Enterprise in Free America," gave us one of the most inspiring and thought provoking talks which we have had the pleasure of hearing in many years.

The Convention Cabaret as the concluding social event of the meeting was held on Wednesday evening, when those present were given the opportunity of witnessing a floor show of exceptional merit. Judging by the number present at this affair and the excellent attendance maintained until the last dance was concluded, we are convinced that the Convention Cabaret continues to meet with popular approval and appropriately brings the Convention to a close in a spirit of friendship and goodfellowship.

Resolutions Adopted Express Industry Viewpoint on Federal Legislation

In view of the growing complexities concerning the relation of Government to business it seems incumbent upon business men, through the medium of their trade associations, to give expression to their joint thought on matters of such character. Mindful of the responsibility resting upon the National Crushed Stone Association as the representative of the crushed stone industry, to express the viewpoint of the industry on Federal legislation, President Weston exercised unusual care in appointing the following men as a Resolutions Committee to undertake this important task:

O. M. Graves, *Chairman*	W. C. Sparks
W. M. Andrews	Stirling Tomkins
N. E. Kelb	Harold Williams
J. A. Rigg	A. L. Worthen

At the concluding session of the Convention on Wednesday afternoon, the Resolutions Committee presented an admirable report reflecting the studious and serious consideration which must have been exercised in its preparation. The proposed resolutions relating to Federal legislation were unanimously adopted and are given for the information of the industry elsewhere in this issue.

Report Given on Seasonal Exemption

At the Monday morning session, Otho M. Graves, reporting on behalf of the Executive Committee, gave a detailed and comprehensive outline of the developments during the past year in connection with the application for seasonal exemption under the Fair Labor Standards Act filed on behalf of the crushed stone industry by the National Crushed

Twenty-Third Annual Banquet

Stone Association. He particularly directed attention to the situation created by action of the Administration in finding that certain areas in the sand and gravel industry were entitled to seasonal exemption whereas developments up to the time of the Convention indicated that a comparable finding for the crushed stone industry seemed unlikely though our application had not been officially denied.

He further pointed out that in view of these circumstances the Executive Committee, at an emergency meeting held on the Saturday prior to the Convention, felt impelled to protest the sand and gravel decision pending the opportunity to discuss further the matter with administrative officials in the hope that upon submission of additional information and data the crushed stone industry could likewise qualify as a seasonal industry. Upon appropriate motion the Convention unanimously approved the action of the Executive Committee and authorized it to continue to handle the matter in accordance with its best judgment.

The membership will shortly receive a detailed report concerning developments in this situation which have taken place since the Annual Convention and accordingly no further comments are offered at this time. It can be said, however, the possibilities that our application will receive favorable consideration are much more encouraging now than was the case at the time of the Convention.

Convention Papers to be Made Available

Limitations of time and space have made it inadvisable to give a detailed account session by session, but we do wish to point out that papers which were presented before the Convention and which proved of unusual interest will be made available either through this and subsequent issues of the Journal or direct.

In Appreciation

In behalf of the excellent representation of ladies present at St. Louis we desire to express to Mrs. E. J. Krause their grateful and enthusiastic appreciation for the excellent program of entertainment which she so capably arranged.

Mrs. E. J. Krause
In charge of Ladies' Entertainment

Many prominent and therefore busy men, experts in their respective fields, gave of their time and energy to address us at St. Louis. To all of our guest speakers, we wish to express sincere thanks for the contributions which they made to the success of our Twenty-Third Annual Meeting.

Also, we are indebted to the members of the various Convention committees, to the presiding officers, and to those in our own ranks who gave papers before the Convention. They did their part well and deserve our sincere thanks.

Resolutions Relating to Federal Legislation Adopted at Twenty-third Annual Convention

War and Peace

The National Crushed Stone Association affirms its intense desire for peace with a full realization of the irreparable destruction by war of lives, homes and human happiness, with crushing depression and economic chaos inevitably following in its wake. The Association approves, adopts and fully endorses the statement on the position of industry to war, made by the National Association of Manufacturers as voiced by its President on September 19, 1939, and calls upon American industry to use its utmost endeavor in working for the continued peace of our country.

National Labor Relations Act

For six years, the nation has been subjected to a national labor policy which has provoked more strikes and disputes than have occurred during any comparable period in our history. Employees, employers and the general public have all shared in the tremendous waste, loss, and suffering which have resulted.

The crushed stone industry is convinced that no sustained or permanent improvement in business or employment will come until the National Labor Relations Act is substantially revised to remove inequalities, to insure impartial administration and fair hearings and to guarantee to employees real freedom in the selection of their representatives without intimidation or coercion from any source whatever.

Fair Labor Standards Act

The Fair Labor Standards Act has been in operation for little more than a year. During that period, as a result of interpretation and administration, bureaucratic regula-

tions have been decreed which go far beyond the declared intent of the law.

Ambiguities in the law have been made more uncertain by official interpretations, and taking advantage of such ambiguities, administrative officials have presumed to "legislate" a new law—distorting the intent of Congress, converting the statute into a device to regulate all wages, interfering with training of new employees, and creating new obstacles to employment and recovery.

While industry has been burdened and injured by this unnecessary regulation, employees have suffered most. By seeking to extend the law to regulate all wages and all classes of employees, the problem of enforcement has been made more difficult.

The crushed stone industry therefore recommends that, if continued in effect, the Fair Labor Standards Act be amended to remove unnecessary hardships and to correct unsound interpretations and policies which have developed in its administration.

Borah-O'Mahoney Federal Licensing Bill

The Borah-O'Mahoney Federal Licensing Bill S. 330 proposes by a broadly extended definition of interstate commerce to remove from state control much industry which is now regarded as intrastate. It would prevent every corporation from engaging directly or indirectly in interstate commerce as thus broadly defined unless it holds a license from the Federal Government. Licensed corporations would be controlled directly and in minute detail by a federal commission vested with broad discretionary powers. Such all-inclusive regulation would place the operation of substantially every phase of their business in the hands of this government bureau.

The penalty for violating any provision of the proposed law may be suspension or revocation of the corporation's license, in which event the corporation would be prevented from engaging in commerce, and the officers or directors held to be responsible for the violation may be disqualified from serving in such capacities in any corporation engaging in commerce, for such periods of time as the courts might order. The chaotic effect of such penalty on employment and on invested capital is obvious.

The crushed stone industry is opposed to the principle of compulsory control of industry by federal license involving discretionary powers of a broad range, and specifically we are opposed to the enactment of this bill.

The Walter-Logan Bill

The crushed stone industry regards with apprehension the continued expansion of governmental powers and believes it of extreme importance that adequate safeguards be made to protect the rights of citizens from an encroachment by administrative agencies beyond the sphere of activities prescribed by law.

A tendency toward such encroachment is noted in the actions of several existing agencies which warrants immediate action both to prohibit a continuance of such abuses and to protect against a repetition of these abuses in the future.

More than a century ago a note of warning to be ever watchful for this condition was sounded by James Madison, one of the framers of the Constitution, who in a current publication of that date said that a function of goverment was to govern itself.

It is for this reason that the Association urges immediate enactment by Congress in the current session, of the Walter-Logan Bill, which is designed to give legal expression to the thought that specific legal limitation must be prescribed as to the powers to be exercised by administrative boards and agencies of the Federal Government.

The bill would establish standards of administrative procedure for all such agencies. The need for such legislation is recognized by the American Bar Association which is urging its enactment. The National Crushed Stone Association recommends the enactment of the Walter-Logan Bill.

Government Competition

The function of the government is primarily political not economic. It is neither conceived nor constructed to compete with its own citizens in the production and distribution of the things used by the people. In so far as government activity invades the field of private enterprise, it threatens the other elements—civil rights and individual liberties—inherent in our system of government.

Private enterprise cannot compete successfully with government enterprise only because of the dominant power of the government and its lack of need to be controlled by all of the elements of cost which are imposed upon private business, and which it must constantly consider. The hidden deficits resulting almost inescapably in government business competing with private enterprise are always paid by the taxpayer. As a matter of fact, when all elements of costs are taken into consideration, private enterprise is able to provide the public with more and better goods and services for a given sum than is government. Government enterprise must necessarily choke out competing private enterprise because of the unfairness of the nature of the competition. And the consequent diminished area of taxation intensifies taxation and so further increases the existing handicap under which private enterprise is unfairly required to compete with the government.

If and when it be needful and proper to undertake public enterprise, the field in which it is to operate should be clearly defined and removed from the area in which private enterprise functions. The continuing of increasing government competition with private enterprise is a major deterrent to the flow of job-creating capital into private enterprise.

The crushed stone industry, in which the harmful effect of such competition is especially prevalent and widespread, is strenuously opposed to the continuing and increasing competition of government in the field of private enterprise.

The Effective Liming of Agricultural Land[1]

By DR. E. E. DeTURK

Professor of Soil Fertility, University of Illinois, Urbana, Ill.

• The following article should be of exceptional interest and value to agstone producers. Attention is especially directed to Dr. DeTurk's "Score Card" for evaluating agricultural limestone.

LIMESTONE, like fertilizer, was born as a by-product. Fertilizers were born as a by-product of the packing industry. Everything they couldn't sell to the customer they steamed and ground and put in sacks and sold it to farmers for fertilizer. That industry has grown until today it is largely a chemical industry, and the packing house by-product end of it doesn't amount to much.

Limestone for agricultural use started, at least in Illinois and I suspect in a good many states, as a by-product industry. It has grown from that. Farmers have finally learned how important it is for them to use limestone, and they have increased their use of limestone during the last decade until a good many producers, including some of the larger producers who originally sold agricultural limestone only as a by-product (one gentleman told me this morning that he used to give it away if the farmers would pay the freight, and he couldn't do that very often) are crushing limestone as a primary product for agricultural use.

Limestone or lime, or both, have been used for probably two or three thousand years, maybe more. We don't know how long they have been used. It has been said, and with some justification, that all of the great civilizations of the world, in the very earliest times, grew up in soils which were calcareous, not on soils that were originally acid.

Limestone was used long before it was realized, however, why it was used on soils. In fact, a realization of the general prevalence of acid soils in regions where the rainfall is heavy enough to produce leaching, is hardly half a century old. When the Pennsylvania experimental plots were laid out, in 1881, limestone was used on some two or three plots in each series, alongside of other treatments, treated just as a fertilizer element, as nitrogen, for instance, or potash or phosphate. It was not considered a general, basic treatment, which would have to underlie all of the other fertilizer and soil building practices, but merely as one of the fertilizers that they should try out alongside of the others.

Things have changed since 1880. Now it is realized in most of the states, where acid soils prevail, that the liming of acid soils is a basic procedure which must underlie, as a foundation practice, all of the other soil building practices. That is particularly true in regions where general farming is practiced rather than highly specialized and intensive farming.

Causes of Soil Acidity

How does it happen that some of our soils in the Middle West, for example, are acid? Most of the material of which our soil was formed was calcareous. Much of it even contained free carbonates and would effervesce if treated with acid.

We weren't there to see, but we can go down deep enough to find unweatherd material from which our soils were formed and get some idea of what has occurred. We know that that was the case.

As the parent materials were gradually changed into soils, two predominant processes were involved. One was that the more refractory minerals were weathered and changed into other products. Most of the primary minerals were crystalline rocks, like feldspar, for example. The weathering process is a chemical process in which water is the chemical reagent, and two kinds of products are formed. One of them is the soluble basic constituents such as lime and magnesia, sodium and potassium, and the other is a non-soluble material which is converted in weathering to an extremely fine condition. We know it as colloidal clay. The farther the weathering process goes, the larger is the accumulation of colloidal clay.

A second consideration is the fate of these products of weathering. The soluble bases, mentioned above, are carried downward by percolating ground water, and, to some extent, lost in drainage. We

[1] Presented at the Twenty-Third Annual Convention of the National Crushed Stone Association held at the Jefferson Hotel, St. Louis, Mo., January 22-24, 1940.

shall see later why they are not completely leached away. The insoluble colloidal material is very fine, and yet it is too coarse to move freely as do soluble substances. Its very slow downward movement and accumulation at 20 to 30 or more inches from the surface is responsible for the heavy subsoil in most

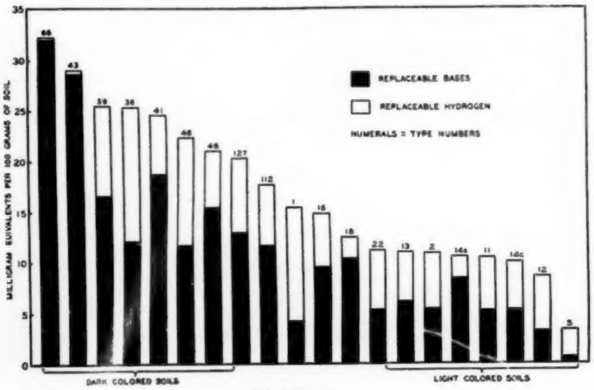

FIGURE 1.

Base-exchange and acidity status of some Illinois surface soils. The whole bar represents the base (or acid) capacity. The balance between bases (black portion) and acid (white) determines the acidity of the soil. Each "milligram-equivalent" of white space on a bar corresponds to a shortage of 1000 pounds of limestone.

soils and the impervious claypan in some very old soils such as are found in the level areas of southern Illinois.

There is in the soil a protective agency which prevents the leaching of soluble bases immediately upon their release from the minerals by weathering. This agency is the colloidal clay. The clay particles, being negatively charged, have an attraction for basic elements and absorb them on their surfaces. They also absorb the acid element hydrogen. Any one of these positively charged elements (ions) if in excess can force another one off the colloid particles and take its place. This is base-exchange. It is a chemical reaction, and the bases, as calcium, form a chemical union with the colloidal clay, so that its removal under natural soil conditions is a very slow process.

In Illinois soils, in the early stages of their formation, the clay was saturated with calcium and magnesium and the soils were neutral or alkaline. With centuries of leaching, the carbonic acid of the soil water slowly removed these bases and converted the clay from calcium clay to acid clay. A soil is approximately neutral when its base capacity is 80 percent saturated with calcium and other bases. If more than 80 percent saturated it is alkaline, if less, it is acid. Figure 1 shows that Illinois soils vary widely in their base capacity, and in their degree of unsaturation, i. e., their lime requirement.

Action of Limestone in Acid Soils

Liming is expected to reverse the above described process, and reconvert the acid clay back to calcium (or magnesium) clay. But first the limestone must dissolve in the carbonated soil water (carbonic acid). Then the dissolved calcium migrates from the parent limestone particle until it encounters an acid clay particle. It is attracted to this particle and immediately attaches itself, dislodging the acid hydrogen. As this process continues, a neutral zone is formed around each limestone particle and increases in size, until, as found by experiment, in a year or so it attains the size of a hickory nut or even a walnut, depending on various conditions. When all these neutral zones overlap, the soil is completely neutralized, but this may take three or four years. Once neutralized, the soil will remain neutral or nearly so for ten to fifteen years, even though no surplus calcium carbonate is present. If surplus limestone is present it performs no service until it dissolves. If calcium carbonate is added in excess of the base capacity of the soil, then it is subject to rapid leaching as rapidly as it dissolves because it does not have the benefit of being caught by unsaturated colloidal clay.

Having established a conception of the action of limestone in acid soils, let us now examine the qualifications which limestone should possess in order to perform this function to the best advantage and with reasonably low cost to the farmer.

Needed Qualifications

In the first place, it is not necessary that the entire mass of the soil be neutralized at once in order to grow acid-sensitive crops, such as clovers and alfalfa, successfully. It is necessary only that neutral areas be sufficiently distributed through the soil so that the roots of the crops grown come in frequent contact with them.

It will be obvious to you that the evaluation of limestone will rest upon two measurements, chemical purity, or calcium carbonate equivalent, and fineness of grinding.

Chemical purity is too self-evident to require discussion. Its total neutralizing capacity is, of course, directly proportional to its content of calcium carbonate together with the equivalent in any magnesium carbonate contained. Limestone ordinarily

should be 85 percent pure to be suitable for quarrying and grinding for agricultural use.

Physical quality, or fineness, is important from the standpoint of the number of particles distributed in the soil, since each particle becomes the center around which a mass of neutral soil is formed, and consequently, the volume of soil that each particle of limestone must neutralize in order that all the neutral zones may overlap, becomes significant. One method of showing the relation of particle size to soil neutralization is to compute the volume of soil which each limestone particle would have to neutralize with a given rate of application. Considering the limestone particles as cubes for convenience in calculation, the results are as shown in Figure 2 for an application of two tons an acre for each of the various size grades. It will be seen at once that on this basis all sizes of 8-mesh or finer have a relatively high rating, because a single particle is responsible for less than a cubic inch of soil, while the next coarser size, 4-mesh, is very poor in this respect, the particles being distributed at the rate of one in each 6½ cubic inches of soil. For quarter-inch cubes (3-mesh) the volume goes up to 15 cubic inches. These calculations are in accord with actual findings of the relative rates at which the different sizes neutralize acid soils.

Evaluating Agricultural Limestone

These results together with those from field experiments in liming have furnished the basis for a

THE "SCORE-CARD" AS FINALLY DEVELOPED

Percentage of Sample	Multiply by	Product
Thru 100-mesh[a]	1.15	
Thru 48, over 100-mesh	1.05	
Thru 28, over 48-mesh	1.00	
Thru 14, over 28-mesh	.95	
Thru 8, over 14-mesh	.80	
Thru 4, over 8-mesh	.33	
Over 4-mesh	00	
Sum of products (fineness rating)		

[a] In the Tyler standard screen scale used, the opening of the 100-mesh is 0.0058 inch on a side. In each succeeding screen of the series the size of the opening is twice that of the preceding one.

method of evaluating agricultural limestone to give its practical value to the farmer so far as fineness of grinding is concerned. Such a method was worked out some ten years ago based on three major considerations: (1) severe dockage of material coarser than 8-mesh; (2) little discrimination between the different sizes finer than 14-mesh; and (3) a valuation of approximately 75 for agricultural limestone typical, as to fineness, of the average then in use in Illinois. (Average "Agstone" had been found to be 75 percent as effective the first year as 100-mesh fineness.)*

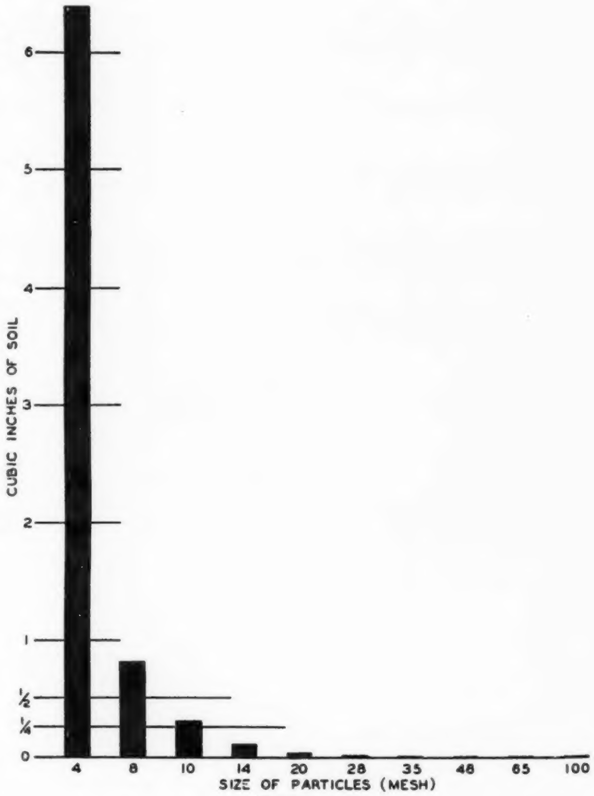

FIGURE 2.

Space distribution of different limestone size separates applied to respective areas of soil at two tons an acre. The volume shown is the volume of soil a single particle of limestone of the given size is responsible for neutralizing if distributed uniformly through the surface soil at the rate of two tons an acre. Note that the critical division line is between the 4-mesh and 8-mesh size.

The sum of the products is the fineness rating. It is a liberal score-card. Everything finer than 8-mesh rates 80 or higher; 4 to 8-mesh is intermediate, but on the low side, and material coarser than 4-mesh is given no value. We have found this score-card very useful, both as a means of educating the consumer in the factors of quality in limestone, and also in educating the producers, and in encouraging producers of undesirable material to improve their

* A time factor is implied in using these bases of evaluation. Results within a year are considered satisfactory by the middle west general farmer. If immediate effectiveness were imperative, then more discrimination would be necessary among the finer sizes.

product. My principal criticism of it is that it places too high a premium on the 48- and 100-mesh fractions, but this appeared necessary to offset the dockage on the coarse end and keep the average value where expriment dictated that it should be.

A practical, educational advantage is that it gives the purchaser a fineness value in one simple figure instead of a series of sieve test readings, and this simplifies interpretation. One could even simplify still further by taking the product of the calcium carbonate equivalent multiplied by the fineness rating. This then would give a generalized index of value in one figure, based on both the physical and the chemical evaluation. This is not merely a juggling of figures, but is supported by theory and common sense.

Optimum Fineness Will Represent a Compromise

During the past ten years the fineness rating of limestone used by Illinois farmers has improved from 75 to 86. Part of this gain has been made by new producers coming into the field with fine grinding, but a considerable part is also due to improvement in products of the older plants. Some further improvement in fineness is still needed. My present judgment is that the fineness rating should be about 90. The optimum fineness will represent a compromise on several points and it appears that limestone having a rating of approximately 90 would represent such a compromise. From the farmer's point of view there should be a high percentage that is fine enough to give reasonably prompt response,—within six months to a year, and the coarser portion should be fine enough to decompose within six to ten years, at least before re-liming becomes necessary. The limestone user does not want the price advanced because of extra fine grinding, and he wants the lowest freight rate possible with shipment in open coal cars. If in such shipment the limestone becomes wet, he wants it to be coarse enough to spread without caking in the spreader.

The producer, in order to meet the consumer's demands, must practice economies in all operations, and reduce to a minimum special operations performed on limestone destined for the agricultural market. Illinois producers generally object to 100 percent through 10-mesh or even 8-mesh, at the regular price, and some of them consider 90 percent through 8-mesh too high a requirement at the current selling price. It may be stated that limestone of which only 85 percent passes 8-mesh may have a fineness rating of 90 as attested by the following sample from a commercial producer in this state.

Percentage of Sample			Multiply by	Product
Thru	100-mesh	28.7	1.15	33.00
48 -	100-mesh	12.2	1.05	12.81
28 -	48-mesh	12.6	1.00	12.60
14 -	28-mesh	16.4	.95	15.58
8 -	14-mesh	15.1	.80	12.08
4 -	8-mesh	12.8	.33	4.22
Over	4-mesh	2.2	00	0.00
Fineness Rating				90.29

These comments are prompted by a recent letter from an Illinois producer, from which the following is quoted:

"It may have escaped notice that much Illinois 'ag' stone is shipped by rail in open top cars. The low rates it moves on can only be maintained if we continue to use open top cars and ship in large volumes. The present specifications on limestone permit the material to stand rain in transit and still spread perfectly in many types of spreaders. It would certainly mess things up if, by reducing the size, the material held rain water and clogged in the spreader."

One further question concerning fineness should be mentioned. For the past two years the United States Department of Agriculture, through its A.A.A. program has made benefit payments to farmers on the basis of the application of limestone as a soil improving practice. The specifications for such limestone were 90 percent through 10-mesh. later changed, for Illinois, to 90 percent through 8-mesh. This specification, if enforced, would eliminate practically all benefit payments to Illinois farmers for use of Illinois produced limestone. Up to the present time it has not been enforced, but it would hardly appear that non-enforcement is the proper solution of the problem. I think I am safe in saying that the University of Illinois would be in full agreement with the specification of a fineness rating of 85 as the basis of benefit payment, the rating to be determined by the Illinois Screen Score Method.

A majority of Illinois producers, based on the quality of their present output, can meet this specification.

Selling the Farmer

We pass on now to a final phase of this discussion, namely, selling the idea of liming, as a fundamentally important agricultural practice, to farmers, landowners, and others. We might have spent the entire hour in showing the benefits of liming, but that is reserved for those who are more directly concerned in producing crops. In short, the experiment station has used two principal technics, with many modifications. The first, begun a third of a century ago, consisted of comparing limed and unlimed land as to its production, both in carefully controlled experiment fields located on many different soils over the state, and in farmers' fields. These experiments showed among other things that some land does not need liming, and eventually it was found that lime needs might vary from large amounts to none even on the same farm or field.

The second major plan for educating farmers in the best use of limestone was begun twelve or fifteen years ago, and was an outgrowth of the great local variability of soils in their lime need. It consisted of developing a simple chemical soil test for lime requirement and then teaching farmers how they could use it themselves for testing the soil of their farms. The use of this test was systematically introduced into farm communities throughout the state. The result was not only a rapid increase in the use of limestone with its consequent benefits throughout the state, but also the saving of useless application of limestone on non-acid soils, and the saving of much clover seed on soils too sour to grow clover without liming. This extension of the use of the soil test for lime need is described in Illinois Agricultural Experiment Station Circular No. 346, which may be had on request.

Part of my discussion, particularly as to fineness of limestone, may not be in agreement with the teachings in many lime using states in the eastern half of our country. We recognize that we advocate a lower grade as to fineness, and one which, because of this fact, is slower in action than that recommended by many of our neighbors. Our reason for this is two-fold. In the first place, specialized types of farming in which crops are grown that require accurate control of soil reaction are not practiced in this state to any great extent. In the second place, for the general farming which predominates, the widespread introduction of legumes for soil building was of primary importance, and to accomplish this would require the large-scale use of limestone, by many farmers, at comparatively small cost. With low-cost limestone, of good enough grade to be effective, Illinois early became the leader in limestone usage and for several years has had the largest consumption of any state in the country. The annual consumption for the past four years has exceeded one million tons and in 1939 it exceeded one and a half million tons.

Future Needs for Agricultural Limestone Unlimited

The prospect of future use is not diminished by this growth in limestone usage. Three-fourths of the 20-odd million acres of cropped land in Illinois is acid, and to correct this condition a minimum of 30 million tons of limestone are needed. At the rate of two million tons a year, this will require fifteen years. Our information as to the durability of liming indicates that at the end of the fifteen years the first-limed areas will be in need of re-liming. In other words, cropping and drainage losses, principally the latter, are increasing the acidity of Illinois soils at a faster rate than the condition is now being offset by liming, and what is true of Illinois is true to at least as great an extent throughout the eastern half of the United States. Faced with these soil conditions there is no end in sight of the future needs for agricultural limestone.

"Solve Our Highway Problem Within Our Present Income," Says Road Chief

"WE ARE standing for, and advocating, the solving of our highway problem essentially within our present income," asserted Thomas H. McDonald, chief of the Public Roads Administration before the subcommittee of the House Committee on Appropriations. "We feel this should be done and that the highway users are paying into the treasuries a sufficient amount that, if we develop and work toward a master plan, the gas tax, the motor-vehicle license fees, and the other special road-user taxes that are now coming in, will support the program. * * *

"The highway program differs from almost all others in this respect, that the amount of funds going into the building of roads now is largely counterbalanced by these direct road-user taxes."

Quarry Haulage[1]

By STIRLING TOMKINS

President, New York Trap Rock Corp.
New York City.

• Developments with regard to quarry haulage have been rapid and highly significant during recent years. The truck-trailer is gaining wide acceptance. Mr. Tomkins' company has pioneered in this field. His experience and observations should prove of great interest and real practical value.

IN THE old days in crushed stone quarries, hand-loaded cars or dump wagons pulled by horses or mules were used to transport rock from quarry to crusher. Following this came the use of first steam locomotives and later gasoline locomotives to push or pull large numbers of small, narrow-gauge cars. Then came the power shovel which made it necessary to replace the small equipment with larger cars and larger locomotives.

Truck Haulage Has Many Advantages

In the early 1920's, the motor truck began to make its appearance on the quarry floor. These trucks were machines discarded from other use, old wrecks of one sort or another, usually of the rear-dump type. They were probably not so cheap to operate as railroad equipment, even though they did do away with much labor in the laying and relaying of track but what they did do to make their use of value was to bring into the job of quarrying an element of flexibility which had never been there before. I think that question of flexibility is perhaps the most important element of all, the gain that we get from the use of these trucks. In former years, most of the larger shovels used in quarries had been of the railroad type, themselves inflexible, and it had made little difference that the railroad equipment was inflexible too, but, as the caterpillar shovel became more popular, much of the advantage gained by its mobile qualities was lost because of the inflexibility of railroad methods of transportation. Caterpillar shovels and trucks brought about great changes in methods of quarrying. It no longer became necessary to shoot big shots, to fill a quarry full of stone, in order to cheapen the cost per ton for the tearing out and relaying of track. Shovels were no longer tied up for extended periods, while solid rock or stones too large to handle were drilled and blasted. If a shovel ran into difficulties in one place, it quickly moved to another and wherever it went, the trucks followed. So great were the advantages, that, since trucks were first used, I have never heard of a quarry in which other types of transportation equipment were substituted for them.

But the early days of the truck in quarries were not without their problems and their headaches. Most of the first trucks used were old, dilapidated affairs, constantly breaking down. Tires, in those days mostly solid, were a frightful problem. Bodies were not designed for the punishment they received. Quarry roads were horrible.

It was toward the end of the year 1926 that my company first started the use of trucks in a big way. We had just built a new plant, and we decided to equip it with trucks for quarry haulage. We bought a fleet, I have forgotten just how many, but about ten, big, new heavy-duty trucks on which we mounted five-cubic-yard side-dump bodies, and we began ten years of struggle with bad roads, tire trouble, broken springs, and leaky radiators, but in spite of all the trouble, they were a great success, and three years later we put another fleet to work in another of our quarries, replacing railroad equipment.

Advent of the Trailer

Until 1938 this type of equipment served. In fact at that time all of the original trucks purchased in 1926 were still running but they were a sorry-looking spectacle. These trucks probably would have been replaced sooner had it not been for the lean years of the depression, but by 1938 they just had to be replaced. By then a few large quarry trailers had made their appearance. (When I say "trailer" here, I really mean semi-trailer.) Many quarry truck users had adopted the pneumatic tire. Most quarry men were attempting to maintain some sort of fair quarry roads. A thorough study of the problem convinced us that these three things were essential to low cost, efficient haulage: trailers, pneumatic tires and, most important of all, good roads.

[1] Presented at the Twenty-Third Annual Convention of the National Crushed Stone Association held at the Jefferson Hotel, St. Louis, Mo., January 22-24, 1940.

Trailers were necessary in order that much larger bodies might be used without placing too great a weight on the pulling unit. The larger pay load, in turn, served to reduce the ever-increasing per ton cost of labor, and the large body made a much more

FIGURE 1.
TRUCK AND TRAILER.

satisfactory unit to load with three and three-quarter cubic yard to five cubic yard buckets on the shovels.

Pneumatic tires were necessary for speed and to make it possible to maintain a good road, as well as to reduce truck maintenance cost.

Good roads were needed for speed, to reduce maintenance and to make it possible to use a light, inexpensive pulling unit.

Experience With Light Truck Units

We had had some experience with light truck units in the $1,000 to $1,200 class. With a special two-axle rear end and some reinforcing of the chassis frame, we had mounted on them three and one-half cubic yard transit-mix concrete mixers, and operated them successfully for two years over normal roads and under the usual conditions which this type of equipment has to face. They had stood up remarkably well, and we became convinced that they would stand up just as well in the quarry provided (1) the haul was approximately level; (2) good roads were built in the quarry; and (3) a trailer could be so balanced that not too great a weight would be placed on the fifth wheel mounted on the truck chassis.

After much study and discussion of the subject, we finally purchased seven units for one of our quarries. These were standard light trucks with the addition of only a heavy duty clutch, some frame and spring reinforcing, and a fifth wheel mounted on the chassis. They cost about $1,100 each. Trailers were designed to carry ten cubic yard side-dump bodies. When they were first put into service, some adjustments were found necessary in the balance but a slight shifting of the location of the axle corrected this, and we have since experienced no difficulty in this respect. A few minor adjustments of springs were made, but otherwise they are running today as originally built, with one important exception. You will note, from figures 2 and 2A, a peculiar form of double hinge. This was designed so that when dumping with an exterior hoist, the center of gravity of the body would always be so located as to cause the body, after raising and tilting, to return to its original position on the trailer without having to be pulled back. This hinge carried the weight when dumping pretty well out to the side, and would have caused overturning had the trailer wheel not come to rest against the side of the hopper. At the same time it threw a terrific twist into the truck. To overcome this, the side of the hopper was built to just the right height, and a strip of flat steel was bolted along the upper edge. On the trailer chassis two outriggers were built so that as the truck came to dumping position, the shoes of these outriggers were carried over the side of the hopper and came to rest just above it. When the body was dumped,

FIGURE 2.
DUMPING OPERATION SHOWING DOUBLE HINGE AND OUTRIGGER.

the outrigger shoes settled on the side of the hopper, and thereafter all of the weight was transferred to them and no strain at all was placed upon either the truck or the trailer.

Importance of Good Quarry Roads

Now to go back just a little. Prior to putting these new units into operation, we completely rebuilt all

of the roads in the quarry. The type of road selected was the old-fashioned waterbound macadam, but we made a good job of it, and it has stood up well, but not without constant care and attention. It is well drained. We sprinkle it when it is dry. It is constantly scraped and, according to its condition, one or two men are employed to care for it. It is the most important element in the transportation system and too valuable to be neglected. Without a good road, the light pulling units would never last, speed would be curtailed, and low cost and efficiency would disappear.

In order to emphasize the importance which we attach to good quarry roads, let me describe for you those we built at another of our plants where we later installed this type of equipment. First we used a bull-dozer plow to plow down the old road or quarry floor to solid rock. On the rock we laid in a heavy layer of small riprap stone (2 in.—12 in.) and filled the chinks of this with a mixture of 1-½ in. stone and screenings. This was thoroughly rolled, and on top of it from four to six inches of 1-½ in.

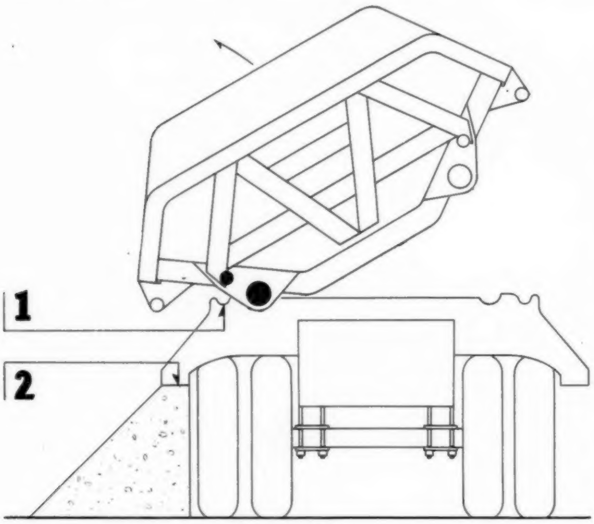

FIGURE 2A.
DETAIL OF OPERATION SHOWN IN FIGURE 2. NOTE (1) THE OUTER SOCKET OF THE DOUBLE HINGE AND (2) THE OUTRIGGER RESTING ON THE WALL OF THE HOPPER.

stone bound with screenings was placed, and this was thoroughly rolled. In this state the road was put into use.

Trucks were run over it for a period of about two weeks, during which time it became thoroughly compacted, much more so than could have been possible even with the heaviest roller. All during these two weeks men were in attendance to correct defects, and at the end of this time we had about as solid a road as could be built. We then covered most of it with a one-inch thickness, down to about three-quarters of an inch, when compressed, of black top—New York State Type 3, and the rest of it, the loca-

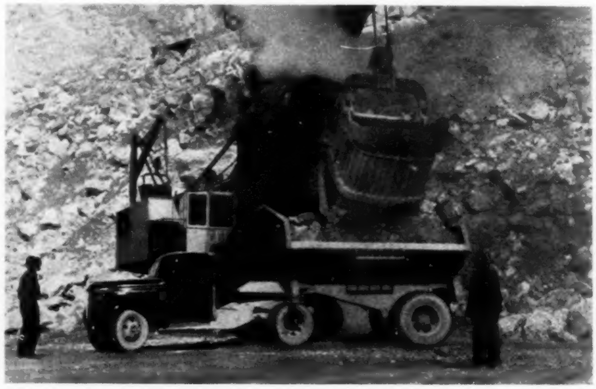

FIGURE 3.
LOADING WITH FIVE CUBIC YARD BUCKET. NOTE MAN READY TO PICK UP ANY STONES THAT SPILL OVER THE SIDE.

tion of which will have to be changed in two or three years, we oiled with a spray tank and covered with stone sand. The road has been in service for almost the entire season, and at the present time neither part of it, that is neither the part that we covered with the Type 3 nor the part we covered with oil shows the slightest sign of wear except for an occasional cut caused by a stone falling off a truck. The trucks operating on this road at speeds of from twenty to thirty miles an hour are shown in figure 4.

Trailers Increase Shovel Output

Aside from the advantages which these trailers have as a transportation unit, they are also responsible for increased shovel output. Any large container is easier to dump into than a small one, and the large body therefore makes for quicker handling of the shovel but, more important still, larger buckets can be used. We increased our three-yard buckets to three and three-quarter yards, and our four-yard ones to four and three-quarters and five. To illustrate the advantage gained from this increase in size of buckets, our old trucks carried an average of four and three-quarter yards while the new ones carry a little better than an average of nine, or approximately double. To load the old truck with a three-yard dipper, in fair digging, re-

quired two swings of the shovel, one with a full bucket and one part full. To load the new body with a three and three-quarter yard bucket requires three swings so that there is a theoretical saving of one swing in four and, while it does not work out

FIGURE 4.
WIDE ROADWAY SURFACED WITH NEW YORK STATE TYPE 2 BLACK TOP.

quite this well in actual practice, there is an appreciable gain in shovel output.

Installation Details

Now just a little about our last installation which, you will agree with me, I think is rather interesting. We had completed the equipping of all of our quarries where we had a level haul. There remained one where we were using an automatic electric railroad system elevating the cars 60 feet from the quarry floor to crusher. Everyone in our organization wanted to put trucks in here, but nobody knew how to get them up the hill. We experimented with large tractors but they did not work satisfactorily though we have since found a two-motored tractor which has demonstrated its ability to pull up the ten per cent incline at satisfactory speed, and we intend trying out some of these for a rather special use next year.

Our general superintendent, Mr. Joe Taylor, hit upon the idea which we are now using. It consists of two hoists which, by the way, are the main hoists from two discarded railroad type shovels made electric by gearing motors to them. These two hoists are sunk in a concrete pit at the top of the 600-foot long 10 per cent grade. The cable from each of the drums passes up over a sheave and attaches to a small but heavy "barney" car running on a 24 in. gauge track. The weight of the car pulls the cable down the incline until it, disappears or sinks into a pit at the bottom, where it is stopped. The truck coming from the quarry runs straddle of the pit and the track and, as soon as it has passed a certain spot, a signal is flashed to the hoist operator by means of an electric eye. The operator starts the hoist and the "barney" car comes out of the pit behind the axle of the trailer. The "barney" car engages the axle, the truck driver throws out the clutch, and the hoist pulls the trailer and truck to the top of the incline, where as the roadway begins to level out, the driver lets in the clutch and runs the truck away from the "barney" car to the crusher, the hoist operator meanwhile having disengaged the clutch of the hoist, allowing the "barney" car to return to the pit in the bottom for another load. With these two hoists we can comfortably handle trucks at the rate of fifty per hour. After dumping, the trucks coast down a 10 per cent incline to the bottom. These units are equipped with brakes on the trailer as well as on the truck in order to assure safe operation. Where the haul is level no brakes are used on the trailer.

This installation at the quarry where we had to haul up-grade completed the conversion of all of

FIGURE 5.
TRUCK ABOUT TO STRADDLE PIT AND TRACK AT BOTTOM OF INCLINE. BARNEY CAR IS IN PIT WAITING FOR REAR AXLE OF TRUCK TO GET AHEAD OF IT. NOTE ELECTRIC EYE ATTACHED TO FRAMEWORK OVERHEAD. THIS WILL SIGNAL OPERATOR WHEN TRUCK IS IN PROPER POSITION TO START BARNEY CAR OUT OF PIT.

our quarries to this type of equipment. In less than a year from the time we ordered the first units, we had purchased a total of twenty-nine. That, gentlemen, better than any words I can use demonstrates what we think of them.

Pneumatic Tires—Their Use and Care in Quarry Service[1]

By G. M. WRIGHT

Goodyear Tire and Rubber Company, Akron, Ohio.

• **The increasing use of pneumatic tires in quarry haulage gives emphasis to the need for practical information concerning their use and care. In the excellent discussion which follows we have the opinion of an expert on ways and means of reducing tire costs.**

I ATTENDED your convention last year in Cincinnati, and for the first time met a number of you. I discussed with those of you whom I met, certain phases of the application of pneumatic tires to quarry haulage units. It was very interesting.

During the past year I visited a number of your quarries. I am glad to say it wasn't confined to one locality. It extended from New York to Iowa, Ontario, down south to the Ohio River.

Due to a very active interest on your part, the suggestion was made that it might not be amiss to collectively discuss certain problems regarding pneumatic tires with you during this convention. Needless to say, we feel honored and privileged that this opportunity might be extended to the company which I represent, as well as to myself.

What I have to say may be old stuff to a number of you. If it is, just please bear with me. It is hoped, however, that a clearer understanding of the problems faced by the tire manufacturer will result and, also, that you will gather information, the practical application of which will help you in the reduction of your haulage costs.

The development of intercity transportation over the improved highways of the United States has taken place since the year 1917. However, it was not until 1927 that pneumatic tires really came into their own. Up to that time it was mostly solid tires. Pneumatic tires crowded the solid tires off the highway. It did not at that time, however, take them out of heavy duty, slow-moving haulage. It was not until the construction of the Boulder Dam that they were first used in that type of work. I will admit that many headaches resulted but they finally won out. Two years later, during the construction of the Norris Dam, there were no solid tires in operation in that particular locality.

The Pneumatic Tire

Since that time they have entered practically every other field, and today are finding general use in all kinds and types of operation. But before discussing the subject with regard to your particular needs, let us first consider what the pneumatic tire is.

Basically it is a container for compressed air. It is capable of carrying loads many times its own weight, while traveling over a variety of road conditions and at all speeds. It is, in itself, a complete unit, just as the vehicle which it supports is a complete unit. But unlike this vehicle, it cannot be changed in design, shape or construction once it has been completed. There can be no cutting off a piece here, welding on a piece there. You must use it as you receive it. Changes can only be made during its manufacture, and its final shape, size and outward appearance only by changing the mold in which it is vulcanized.

Every ounce of horsepower developed by the motor, which results in travel of the vehicle, must be transmitted through the tire to the ground and through a very small contact area of relatively few square inches. The tire must be able to flex, withstand shock, and conform to the surface over which it travels. It must be able to withstand severe strains resulting from the sudden application of brakes.

Under all these conditions it must carry a load which, in many instances, is fifty times its own weight. Compare that with the weight of a truck and the load it carries. It may carry a load twice itself in weight, maybe more, but the ratio is 50 to 1 in the case of the tire.

These are just a few of the problems that the tire engineer has been called upon to solve, and we think that you will agree that up to the present he has done a pretty fair job, though it is admitted that there is still much ground yet to cover.

Load-Carrying Capacity

I have just mentioned load. This little four-letter word when combined with another of an equal number of letters spells "overload," the bugaboo to the tire engineer as well as to the tire user.

[1] Presented at the Twenty-Third Annual Convention of the National Crushed Stone Association held at the Jefferson Hotel, St. Louis, Mo., January 22-24, 1940.

After years of experience, during which countless experiments were conducted, certain empirical formulae have been established by which the load-carrying capacity of pneumatic tires has been determined. These formulae have been adopted as standard by the tire industry. Some of you are familiar with load tables which have been established for various types of service. You may wonder why a given size of tire, under different conditions of operation, has a different load rating. Basically, the load-carrying capacity of a tire depends upon the air pressure within the tire. The higher the pressure, the higher the load capacity. However, there are limiting factors as to the amount of air that can be used.

First among these is the stress imposed upon the individual cords. These cords supply the structural strength of the tire. High air pressure, which increases the cord stress, may result in failure. It would not be practical, even if possible, to calculate load ratings covering all types and conditions of service. We have therefore set up a few basic tables to cover average conditions. These tables are based upon different, predetermined cord stress factors which take into consideration the various operating conditions, such as speed, heat, impact load and others.

Since the highway truck tire was the first developed, it is only natural that the stress factor employed in arriving at its proper load rating should be used as a basis for calculation.

Heat is the large tire's worst enemy. It is the result of speed in flexing. Therefore, for high speed operations, flexing must be kept at a minimum. This means high inflation pressure. However, since high speeds mean high impact loads, it is easily seen that the load capacity of a tire going into that kind of service necessarily must be somewhat limited.

For slow operations, both on and off improved or semi-improved roads, heat is not so much of a factor. Other things being equal, the amount of flexing in a tire is dependent upon the air pressure within the tire. Consequently, for this type of operation, that is slow-moving on improved or semi-improved roads, the pressure can be less. This pressure, being less, reduces the cord stress. In service of this kind, when the tire often comes in contact with large objects, such as stones and pieces of rock, the lower air pressure allows the tire to envelope the object, and no damage results to the cords, whereas had the cords been under high stress, the same object would have produced a high impact load, concentrated upon a small area, and cord failure would probably result.

We have, therefore, arrived at four separate load tables to meet four different general conditions of service which industry has established as representing the present-day field of the pneumatic tire. These four conditions are: (1) Our basic truck and bus table for all-around road usage. By this term "all-around" we mean average operating conditions, including high speeds, such as buses and freight hauls. (2) Load and inflations for off-the-road service where the maximum speed does not exceed 10 miles per hour. This applies to such operations as earth moving, quarrying, mining, logging, excavating, etc. (3) Similar to Number 2 for type of service, but where the speed may reach a maximum of 25 miles per hour. (4) A combination table for 25 miles per hour over improved or semi-improved roads, and 10 miles per hour off the road, such as may be found in certain strip-mining and quarrying operations.

Load Ratings Depend Upon Operating Conditions

Just as an example of the actual difference in load ratings for given size tires under these four conditions, let us take the 13.50 x 20 - 16 ply tire. For highway service at high speeds, the maximum rating for that tire is 8200 pounds at 95 pounds inflation pressure. Please note the inflation pressures. At ten miles an hour, off the road, the rating is 8940 pounds, but at 55 pounds inflation. In this same service, but boosting the speed to 25 miles an hour, it is only rated at 8000 pounds. That is a drop of 940 pounds from the ten mile an hour table, at 55 pounds.

Going on to improved or semi-improved roads at 25 miles an hour, where the chance of impact is less, where the speed is maintained more continuously, the load rating is 8800 pounds, but the inflation pressure is boosted to 65.

To impose a greater load than the maximum recommended for a particular size of tire usually results in decreasing the mileage life, which means increased mileage costs.

There are instances where this may not hold true. However, if you think your particular operation is one, I would suggest you first call in a tire man and then follow his recommendations.

Selection of Proper Size and Type Important

Remember, the tire equipment on your unit represents an investment constituting a substantial part of the total you invested in the complete unit.

As to the matter of overload, it has been pretty well established for general service that if you over-

load your tire 10% and continue this overload condition throughout the life of the tire, you may expect a decrease of from 15 to 18% in the life of the tire. If this overload is boosted to, say, 30%, you may expect a decrease or a loss of potential tire life of at least 43%. There have been, and still are, many instances of tendency on the part of some equipment manufacturers to "under-tire." This is a competitive situation, and, from the standpoints of ultimate tire performance and low-operating cost, one which should be avoided.

If you are contemplating the purchase of new haulage units, may I suggest you discuss the question of proper size and type of tire with a representative of some tire manufacturer, and between the two of you determine your tire needs. Include this in the specification that is sent to the equipment manufacturer, when ordering your unit.

After your unit has been received and put in operation, you should then determine the proper load to be carried on that unit. It may be a ten-ton unit; it may be a fifteen-yard unit. You must determine, however, how many dippers full to put on your load so you will not improperly load your tires.

This is a service which all tire manufacturers are glad to give you. They usually carry loadometers with them in the back of their car. Many times I have gone along the highway and seen a unit working. I have stopped, got out my loadometer and weighed it up. We are very glad to do that. Any tire manufacturer will be very glad to do that, and he is quite anxious for you to avail yourselves of that service.

So far I have just discussed only the load carrying part of the tire, namely the cords which constitute the body and impart strength to it. Just a moment ago I mentioned type of tire. This has to do with the outward design and is an item of much importance. The rubber tread and side wall of a tire, no matter what design, do not add any worth while strength to it, and, consequently, do not affect its carrying capacity. They do, however, protect the body of the tire from cuts and small object impacts. The design, especially that of the tread, determines to a great degree the useful life of the tire.

The woods are full of different tread designs. You have a variety from which to choose, but, when making your choice, keep these things in mind Specially designed tires are made for operating in rock, mud and dirt, high speed highway transportation, and other specialized services. Make your selection from those designed for your particular needs. If hauling blasted rock from a shovel to crusher, choose the design which will best withstand cutting and chipping and offer greater resistance to road shock. Such tires have massive tread elements and unusually thick tread and side wall rubber.

Do not choose a wide open design. The heavy trade blocks help distribute road shock. In a wide open design, fair sized pieces of rock get between these blocks and cause tire injury.

Avoid designs having the elements of the tread so closely spaced that small chips or sharp stones will be picked up. Regardless of how good a haulage road you maintain, there are always chips and small stones lying on the surface which, if picked up and held by the tread design, may sometimes cut their way into the body of the tire.

If hauling soft, chalky rock, and the quarry floor is such that cutting, chipping, and road hazards are nil, but where traction is a basic requirement, choose a tire especially designed to give traction. The elements of the tread should be sturdy and spaced fairly far apart. I might add right here that treads designed for traction usually have elements or bars at an angle, and it is quite important that you apply the tire to the wheel to rotate in the proper direction. There is an indicating arrow usually found on the side of the tire which will show you which way they should be mounted on driving wheels. For trailing wheels, the direction of the rotation of the tire should be reversed. Where traction is necessary, you have soft going as a rule, and the bars are put at a certain angle so that the tread design will clean itself. If you reverse this direction, this tread will not clean itself, and you naturally lose appreciably in traction.

If your operation is not on the quarry floor but over improved roads where cutting, chipping and road shock hazards are eliminated but high speeds are maintained, almost any highway type of tire should prove satisfactory.

On drive wheels and on trailing wheels equipped with brakes, avoid designs which contain unbroken, circumferential grooves. Such designs reduce traction, and a spinning tire of this type will cut easily, especially at the bottom of grooves. A broken-up design increases traction and, in addition, tends to eject pieces of stone that might otherwise ride along and cause damage.

Again, I say in case of doubt as to the proper size and type of tire, call in your tire man.

So far I have spoken only of the tire. Before going on to the next and last part of this discussion, I wish

to mention very briefly the rim upon which the tire is mounted. Experience has taught us many things concerning rim shape and size. My only admonition for the moment is that in all cases you use the rim size recommended for the size of tire being used. If you get oversized tires, also get the larger rim which fits the tire. To disregard this will not decrease your operating cost. The successful operation of a tire is largely in the control of the equipment operator.

Cost of Tire Operation

As already has been mentioned, the tires on your haulage equipment constitute an appreciable part of your investment. Replacement is expensive. Proper care and attention are needed in order that transportation costs be kept at a minimum.

If I were asked to name the one most important item affecting tire operation cost, my answer would be: Correct air pressures. There are a number of other important items to be looked after, but before mention of them is made, let us dwell for a moment on this one.

Earlier in this discussion it was pointed out that the load-carrying capacity of a tire varies with the type of service in which it operates. In this connection I wish to call your attention to the relative maximum inflation pressures permissive for the four types of service that were mentioned: 1. For high speed over improved highways, high inflation. 2. For low speeds, that is ten miles an hour, in off the road service, low inflation. 3. For off the road service at 25 miles an hour, low inflation, but note that the load-carrying capacity in that case is reduced from that of ten miles an hour, in the case mentioned it was from 8940 pounds to 8000 pounds. 4. For service on improved or semi-improved roads, at 25 miles an hour (that falls in your category), medium inflation.

No single item will run tire costs higher, more quickly, than incorrect air pressures. Correct air pressure is to the tire what correct oil pressure is to the motor. Too much pressure means excessive cord stress, and ordinary impact loads may cause failure of over-inflated tires. Over-inflation also stretches the tread and side wall rubber, making them more susceptible to cutting.

After all, all tread wear is just a series of small cuts and abrasions. You all know that with a rubber band, if you stretch it, just nick it with a knife, it breaks quite easily. If you let it lie on the table and take your knife, you saw it a little bit before it breaks. It is the same principle there.

Too little pressure causes excessive flexing at localized points, and failure due to fatigue results—that is fatigue of the cords in the tire. It may also cause slippage of the tire on the rim or damage by crushing the tire against the rim.

Uniform pressures across the axle are necessary to insure uniform loading. Changes in atmospheric temperature will cause changes in pressure, but these are usually so slight that you do not have to regard those. Extreme changes, however, should be reckoned with.

The constant flexing of a tire will create heat which in hot weather will raise the air pressure. This should be taken into consideration when the pressures are being checked.

In the matter of under-inflation, I mentioned a moment ago the loss in expected tire mileage due to overload. This is just another way of saying it. If you under-inflate your tire for a given load, you are overloading the tire. If you constantly run at 10 per cent under-inflation, you may expect, on the average, five per cent decrease in the life of your tire. If you run 30 per cent under-inflation, you may expect, on the average, 33 per cent decrease in the life of your tire.

Important Factors in Reducing Tire Costs

I now wish to offer a number of suggestions which, if followed out, will go a long way to reduce your tire costs. Select the right size and type of tire for the job to be done. Do not hesitate to ask the advice of the tire manufacturer regarding this. Maintain proper inflation pressures. I have just discussed this but it cannot be mentioned too often. It is the one item which is entirely within your hands. Give it the same attention that you do a greasing job, and you will be money ahead.

Keep valve caps on the tubes. This cap does two jobs, and I might say that it is the most generally disregarded item of the small items. The valve cap keeps dirt from reaching the main valve seat and forms a secondary air seal over the end of the valve. A great many slow leaks will be eliminated by the

constant use of valve caps. Keep a supply of valve caps on hand and replace the old ones when they first develop slow leaks.

Inspect your tires regularly. Pick out all foreign materials. Repair snags and cuts before they develop to a point requiring major repair. Put new replacement tires on drive wheels and, if possible, run the older tires on the trail wheels. Keep your haulage roads in good condition. Make fills, use graders, clean up around the shovel. In large operations, have a man patroling the road at all times. He will pay for himself in fewer tire repairs and fewer delays.

I think that the matter of haulage roads is one of very great importance. I know that it has meant to some operators the difference between successful operation and not successful operation. Steer away from bad spots in the road. If a 13.50 x 20 tire loaded to 8500 pounds and inflated at 55 pounds and going ten miles an hour hits a rock three inches in diameter, it will develop an impact force which is twice the static load—17,000 pounds, a momentary overload of 100 per cent.

Remove rocks caught between duals. Remove any object that may become lodged between the rim flange and the tire bead. Partially deflating the tire will help in both of these operations, but be sure, if you do deflate it, to reinflate to the proper pressure.

Make regular checks on front wheel alignment, bent axles, sprung frames, shifted or broken springs, and so forth, to avoid fast scuffiing wear from misalignment. Do not mount tires as duals if there is a difference of more than one-quarter of an inch in diameter. The larger of the two tires should go in the same position as the larger of the two old tires. For instance, if the original tires show that the outside tire wore down faster than the inside tire, the new one should be mounted with the larger of the two on the inside. Dual tires should have the correct spacing to prevent rubbing or "kissing". When one side wall has been badly scuffed, the tire should be turned around so the other side-wall can take its share of the scuffing before the tire finally goes out of service. Oftentimes tires have gone out of service with one side wall full of cuts and slashes, while the other side is scarcely nicked.

In this connection, I would like to refer again to what was said about different tread designs. Those for traction we call a "one-way" tread. If you do shift your tires to take advantage of the inside side-wall which has not become scuffed, remember to have the tire rotate in the proper direction, providing, of course, it is one of these tires with a "one-way" tread.

All rims should be cleaned before applying tires, so that they will be free from rust. Do not use any kind of oil or grease on the rim or the bead of the tire. It is a very common practice. It is pretty hard to change some of these big tires, and you will find a garageman putting a little grease or something on the bead of the tire and on the rim so it will slip on easily.

Many times the rim flange is smashed in service. If the damage is great enough so the tire is forced away from the flange, the rim should be repaired. It is highly important that the original rim shape be maintained.

When mounting tires, all foreign material should be cleaned out from the inside. After inserting the tube, put a little air pressure in it. Run your hand down between the rounded out tube and the inside of the tire to release any trapped air. Be sure there are no wrinkles in the tube or the flap when you are rimming. Keep the valve cap on the tube while mounting, to prevent damage to the valve treads.

Mounting and dismounting tires is dangerous business. When dismounting, be sure all the air is out of the tube before the side rings are plyed off. To be absolutely sure of this, it is best to let the air out of the tube before removing the wheel from the vehicle.

When mounting, be sure the complete rim is assembled correctly, before starting to inflate. As an added precaution to this, it is well to stand the tire with the loose side ring of the rim next to a post or a wall or some other stationary object. Then if it so happens that the man does not have the locking ring in place and inflation blows it off, he is not going to get hurt. Some very bad accidents have happened by disregarding this little item of safety procedure.

Oil or grease will soften and deteriorate rubber. In ordinary service this material does not remain

(*Continued on page 29*)

Ohio Highway Experience with Crushed Stone[1]

By R. R. LITEHISER

Chief Engineer, Bureau of Tests, Ohio Department of Highways, Columbus, Ohio.

• Because of his extensive experience in the field of highway engineering Mr. Litehiser's observations concerning the use of crushed stone in Ohio should prove of especial value to crushed stone producers.

OHIO is unusually fortunate in having available an abundance of good quality limestone and dolomite in the bedrock of the state, which serves as an excellent source of material for crushed stone. The rock strata of the western half of Ohio are made up of sediments of Ordovician, Silurian and Devonian age, and by far the most common and widespread rock types in this area are limestone and dolomite. The most wide spread single system of source rocks for crushed stone in Ohio is the Silurian, which outcrops over an area of approximately 11,500 square miles, or approximately 1/4 of the state, and has a larger areal distribution than the strata of any other age in the state. The Brassfield, Niagaran and Bass Island limestones and dolomites of the Silurian System, with a combined thickness of over 600 feet, afford an unusually large and easily accessible source of raw material. The Columbus and Delaware limestones of Devonian age with a combined thickness of approximately 125 feet, outcropping in a belt approximately 10 miles wide through the center of the state, extending from a few miles south of Columbus to Sandusky on Lake Erie, provide another excellent material source for crushed stone.

Due to the abundance of good quality stone in the western part of the state, the thinner and less readily accessible deposits of eastern Ohio have not been extensively developed. The bedrock here is composed largely of shales and sandstone. However, limestones occur commonly interbedded with these strata. In the Mississippian System, which outcrops in a broad belt, extending from the Ohio River to within a few miles of Lake Erie, across the east-central portion of the state, the Maxville limestone occurs in scattered outcrops which reach a thickness of 75 feet in some localities. Strata of the Pennsylvanian and Permian Systems outcrop over most of the eastern one-third of Ohio and have an aggregate thickness of approximately 1,700 feet, of which about 10 per cent is made up of relatively thin limestone beds. Although these thin beds are by no means comparable to the vast limestone resources of western Ohio, they afford valuable local sources of material for crushed stone in the eastern part of the state.

Bituminous Concrete

The use of crushed stone has played an important part in the development of bituminous concrete in The Ohio Highway Program. In 1917, records of our Laboratory show there were less than 1,000 tons of bituminous concrete used by the Ohio Highway Department but the use of this material has played a gradually increasing part in our program until in 1939 about 737,000 tons of the several types were used.

From 1917 until 1931 the principal surface types specified were T-4, a modified Topeka, T-5, a bituminous concrete coarse mix, and T-6, a sheet asphalt mixture. The Modified Topeka mixture, as specified during this period, required about 20 to 45% of material between the ¾" and No. 10 sieves, and from 8 to 15% of mineral filler. However, this type was dropped from the specifications after 1929. The bituminous concrete coarse mix used from 58 to 70% of coarse aggregate, for which a definite size was not specified until 1931, and this mixture required about 5% of material passing a 200-mesh sieve. The sheet asphalt consisted of a fine aggregate with from 12 to 20% of mineral filler. It will be noted, that all of the above mixtures depended in varying degree upon the mineral filler to develop stability.

Due to the cost of this type of construction, which consisted mainly of one of the above surface types on a new portland cement concrete base, and the hand finishing methods used, bituminous concrete was not used extensively for highways at that time. The production dropped from 37,000 tons in 1925 to 1,500 tons in 1926, and from 1925 until 1931 the use of

[1] Presented at the Twenty-Third Annual Convention of the National Crushed Stone Association held at the Jefferson Hotel, St. Louis, Mo., January 22-24, 1940.

bituminous concrete was confined almost entirely within corporate limits.

In 1930, however, an experimental road was built in Butler County to salvage an existing macadam pavement. This project was of one-course construction, hand-raked, and wooden side-forms were used. The specifications under which this road was built, required from 55 to 70% of aggregate between the 1-1/4" and No. 10 sieves, and no mineral filler was used. This mixture depended largely upon the coarse particles for its stability. During the same year a cold-mix specification appeared as part of a series for patching materials and about 28,000 tons were used.

In 1931 further variations were tried in the salvage field and the total production for the year was 156,000 tons. On a project in Brown and Highland Counties a cold-mixed, cold-laid bituminous concrete was placed between concrete headers by means of a finishing machine. Another project of this type was built in Morrow County. Crushed stone was used in both mixtures. In the hot-mixed field, a salvage project was built in Licking County on which the base widening was of macadam and the bituminous concrete was placed with a finishing machine which ran on forms. A limestone coarse aggregate was used with a natural sand on this project.

Another project, built in 1931 in Greene County, is notable as the experiments made on different gradings of the crushed stone were forerunners of the aggregate size specifications later adopted for the different surface types and, in addition, limestone sand was used throughout this project. An attempt was made to develop a surface of non-skid texture, and the angularity of both the fine and coarse aggregate particles was noted as being of great importance to attain that end. The advent of the finishing machine, noted previously, was the first step toward mass production in the construction of bituminous concrete highways.

Bituminous Concrete Base Widening

The next development was in 1932, when a project was constructed in Seneca County, using a bituminous concrete base widening, under which was placed a 1" insulation course of limestone screenings. Since then nearly all salvage projects have been designed with a bituminous concrete base widening and insulation course, where widening was needed, while other projects have been constructed using a full width bituminous concrete base construction.

First Use of Bituminous Concrete Paver

Prior to 1936, the plant mixed bituminous concretes were divided into the hot mix group, which used a fairly low penetration asphalt, and the cold mix group, which used a fairly high penetration asphalt. However, in 1936 the bituminous concrete paver was first used with a densely graded mixture using a fairly soft asphalt. This mixture tended to bridge the gap between the hot and cold mixes inasmuch as it was a densely graded mixture, mixed with less heat than is normally required for a hot mix, and with the same asphalt used in a cold mix. The development of the bituminous concrete paver was a further step toward mass production in this field, as it eliminated the manual distribution of material before the screed, and it did not depend upon side forms.

Specifications

Our present specifications cover such types of bituminous concrete as T-34, a road mix type; T-35, a dense, long gradation, high penetration asphalt type; T-50, a dense, skip gradation, low penetration asphalt type; T-60, an openly graded cold mix type; T-61, a semi-dense tar type; T-136, a densely graded tar type; and T-137, a densely graded oil aggregate type. In T-50, T-60, and T-61 the coarse aggregates must be 100% crushed. The sizes of the various aggregates used in the above mixtures range from material 100% passing a 2" sieve, used in the base courses, to material 100% passing a 1/4" sieve, used for one of the surface types. Both long and skip gradations are used in the various surface types. Manufactured sands, predominantly crushed limestone, are commonly used in the base, intermediate and surface courses of all types and must meet one of the following specifications:

M-2.5

Pass. No. 4	100%
No. 4 - 6	0- 5
6 - 8	0-10
8 - 16	15-40
16 - 50	25-60
50 - 100	5-35
100 - 200	2-10
200	0- 5

M-2.11

Pass. No. 4	100%
8	90-100
16	50-75
30	30-50
50	10-30
100	3-10

The finer of the two sands is used primarily in sheet asphalt.

During the past year attention was focused on the oil aggregate mixtures. This material is intended for resurfacing only, on fairly low traffic roads, where an inexpensive material can be used to advantage. The specification for this mixture requires 100% passing a 1" sieve, 75 to 100% passing a No. 6 sieve, 13 to 35% passing a No. 50 sieve, and 5 to 10% passing a No. 200-mesh sieve. It further states that mineral filler need not be added if the fine aggregate to be used contains the necessary amount of fines. For one project constructed in Union County, the mineral aggregates consisted of a scalped, crusher run limestone which contained the necessary amount of fines, while on another project of this type in Clinton County, 3/8" to No. 8-mesh crushed stone and limestone screenings containing sufficient fines, were used. On both of these projects, the cost of mineral filler and the handling necessary to incorporate it into the mix, were eliminated.

It is significant to note that the various densely graded mixtures use from 90 to 96% of mineral aggregate while the openly graded mixtures use from 92.5 to 96.5% of mineral aggregate. However, the densely graded mixtures may be expected to weigh 3,800# per cubic yard, while the open types can only be expected to weigh 3,500# per cubic yard.

Modern construction methods and modern plant equipment have increased the daily production of bituminous concrete to 600 tons (10 hours) with some plants producing as much as 1,000 tons per day (14 hours). With such production capacities, and in view of the control necessary to have the finished product meet all of the elements of modern mix design, the necessity for rigid control of the raw materials becomes apparent, and consequently the variations in aggregate gradings, due to segregation, become a problem of major importance. The five or ten-minute delay encountered when an excess or deficiency of one size of aggregate is found in the bituminous concrete plant, will mean a loss of many tons of the finished product per day, in addition to the cost of handling material which cannot be properly combined for the mixture. Producers who supply these large quantities of aggregates, can build up sales advantage for themselves, by the care they exercise not only in initial sizing but in subsequent handling and stocking.

Portland Cement Concrete

Crushed stone also plays an important part in our Portland cement concrete program, although in this field our specifications do not require a 100% crushed aggregate and recognized crushed stone, gravel, and slag as alternates. Our experience with these three coarse aggregates, as measured by the compressive strength of the cores cut from the finished pavement and base, equated at an age of 28 days, is shown in Figure 1. Strengths for 1939 were not available at the time the table was prepared, but have since been assembled and show the same general picture except that the average compressive strength is slightly higher, indicating perhaps that we slightly improved our concrete practice, as compared with the average of that for 1935 to 1938 inclusive.

Similar experience on the basis of transverse strength, as measured by the beam test, is shown in Figure 2, where experience for the years 1935 to 1938, inclusive, has been combined again. We appear to have about the same experience with concrete made from each of the three aggregates, except it is to be noted that concrete made with limestone as a coarse aggregate, has a slightly higher average modulus of rupture at practically all ages than has gravel and slag concrete.

It may be recalled that I offered some constructive criticism on specifications for stone sand when I had the pleasant experience of talking before your group at your 1937 convention in Cincinnati. At that time I pointed out that our specifications

SUMMARY OF 1935, 1936, 1937 AND 1938.
CONCRETE CORE COMPRESSIVE STRENGTHS
(Strengths Computed at 28 Days)

Coarse Aggregate	Proportions	No. of Tests	Average Compressive Strength (Lbs./Sq. In.)
Gravel	1—5½	1,282	4,801
Limestone	1—5½	823	4,549
Slag	1—5½	140	4,434
Gravel	1—7½	849	4,159
Limestone	1—7½	479	3,833
Slag	1—7½	471	3,540

FIGURE 1.

for stone sand were being changed to eliminate material between 3/8" and No. 4, and to reduce the amount of material between the No. 4 and No. 8 sieves, which in our observation consisted in the main of slabby particles, which were not conducive to workability in the concrete in which they were

SUMMARY 1935, 1936, 1937 AND 1938
TRANSVERSE STRENGTHS

Coarse Aggregate	Proportions	Age in Days					
		3		5		7	
		No. of Tests	Av. Modulus of Rupture (Lbs./Sq. In.)	No. of Tests	Av. Modulus of Rupture (Lbs./Sq. In.)	No. of Tests	Av. Modulus of Rupture (Lbs./Sq. In.)
Gravel	1—5½	1,642	598	1,039	672	1,785	713
Limestone	1—5½	675	597	583	675	774	724
Slag	1—5½	596	596	501	667	802	721
Gravel	1—7½	561	488	711	552	1,036	613
Limestone	1—7½	405	502	311	589	431	628
Slag	1—7½	442	462	487	531	674	586

FIGURE 2.

introduced as part of the fine aggregate. While stone sand has not been extensively used since our specification was changed, I have obtained the average compressive strength of cores from concrete pavement made with stone sand in 1937 and 1938. The average compressive strength of the 108 stone sand cores was 4600 pounds per square inch, equated at 28 days. The average for the same two years of 855 cores including all fine and coarse aggregates, was 4580 pounds per square inch. This would indicate that on the basis of compressive strength of the cores, our stone sand concrete, following the change in our specification affecting stone sand, compares favorably with similar concrete placed during the same two years, with all aggregates. Figures for 1939 are not available inasmuch as stone sand was not used on any of our concrete pavement jobs last year.

Although our Laboratory records do not include figures for the amount of crushed stone used in macadam and in surface treatment, the tonnage is considerable. Waterbound macadam has a very definite part in a great deal of our pavement widening.

Whenever a group places a Testing Engineer on its program, it leaves itself open to hear sooner or later, something about tests or test data, whether such comment has any logical place under the subject assigned or not. Both aggregate producers and testing engineers have had particular interest during the past five years in the Los Angeles Abrasion test, and in the Soundness Test by use of Sodium Sulphate or Magnesium Sulphate. Of the two, the Los Angeles abrasion test appears to be the more promising working tool. It provides an index to the ability of an aggregate to withstand impact as well as abrasion, which alone was measured in the Deval abrasion test which has been in use for many years.

Relation Between Los Angeles Abrasion Test and Modified Abrasion Test

Recognizing the deficiency in the Deval abrasion test, Mr. A. S. Rea, who was Ohio's Testing Engineer for twenty years preceding his death in 1930, had introduced what we call the "Modified Abrasion Test" for use on crushed stone, slag, and gravel alike. The test is essentially the Deval test for gravel in which a charge of 6 cast iron spheres weighing approximately 0.95 pound each is placed in the cylinder with the aggregate as an abrasive charge. Since the introduction of the Los Angeles abrasion test, our Laboratory has made approximately one hundred and fifty such tests on commercial aggregate from representative sources throughout the State, in an effort to establish a conversion factor between our present specification limits, expressed in terms of the Modified Abrasion Test, and the corresponding limits expressed in terms of the result of the Los Angeles Test. These tests indicate that for our hardest grade of aggregate, which has an upper limit of 18% as determined in the Modified Abrasion test, that the corresponding limit with the Los Angeles abrasion test should be about 25%. For our next grade of aggregate, which is that used in all surface courses, the Modified Abrasion limit is 24% and the corresponding limit using the Los Angeles Abrasion test appears to be about 35%. For our third grade of aggregate, which is used in all base course work, our specifications establish a limit of 32% using the Modified Abrasion test, where the corresponding limit using the Los Angeles Abrasion test seems to

be about 45%. We recognize that our data are limited, and therefore too much weight should not be given to the fact that our tests indicate lower limits in terms of the Los Angeles Abrasion test, than are in use where aggregate specifications already include this test.

Soundness Tests

Turning now to the Soundness Test, inasmuch as tonnage, in which aggregate producers are fundamentally interested, bears such a definite relation to the satisfactoriness which aggregate gives in service, I believe I can safely assume that aggregate producers are just as interested as those who build their highways and bridges with such aggregate in the form of Portland cement concrete, in furnishing aggregate which will contribute its part toward the durability, as well as toward the structural strength of those highways and bridges.

In an effort to assist themselves in determining in advance whether an aggregate will contribute durability to the concrete in which it is used, engineers devised the Soundness Test, using sodium sulphate or magnesium sulphate. Sincere use on the part of engineers of this test, has undoubtedly resulted in the rejection of some aggregate, which might have made satisfactory concrete. However, as stated in most present day specifications, the Soundness Test, using sodium sulphate or magnesium sulphate, is recognized only as a guide in selecting aggregate, and the service record of concrete in which the particular aggregate has been used, is also taken into consideration. Where such use is made of the Soundness Test, I personally consider it a worthwhile working tool in a Testing Laboratory, charged with the responsibility of obtaining a satisfactory material with which to build.

It may be that the Freeze and Thaw test, which many laboratories, including our own, are using experimentally in an attempt to find a more satisfactory working tool with which to determine the effect on durability of a particular aggregate, will prove more satisfactory inasmuch as it employs directly the same factors which are at work in nature in deteriorating any structural body in which they can gain a foothold. However, the Freeze and Thaw test at best takes considerable time and does not offer much promise as a routine test for acceptance or rejection of aggregate.

Pneumatic Tires

(Continued from page 24)

on tires long enough to do any damange. However, before storing a truck for any length of time, a tire should be cleaned and covered. The covering will prevent the tires from direct or indirect sunlight, which quite often causes surface checking and cracking.

Another help, when storing, is to block a truck up off the tires and then release the air pressure.

Another thought, especially to those of you who may be running on solid tire equipment and would like to try out pneumatic tires, don't make the mistake and think you can put one unit on pneumatic tires to run on the same road as the rest of the fleet which are on solid tires. You will be sadly disappointed. You cannot maintain a proper roadway that you need for pneumatic tires by running solid tires along with them.

I have tried, in the time allotted to me, to point out some of the problems which confront the tire engineer and which have, to a large extent, been solved by him. I believe, however, that his real work lies ahead. You as operators have and will continue to keep him busy.

I have also made certain suggestions to you, having in mind one thing, *lower operation cost.* To those of you who have not as yet changed to pneumatic haulage equipment, bear in mind that the pioneering in this field has already been done. Lower haulage costs *have* resulted. You are in a position to profit by the experience of others.

I wish to say, however, that satisfactory results can be obtained only by the reasonable observance of a few simple rules, some of which have just been mentioned.

May I again remind you that the tire manufacturer is ready and anxious to help you in every possible way, whether you are now operating with pneumatic tire units or contemplating a change to them. Do not hesitate to avail yourself of this service.

In bringing this discussion to a close, it is our hope that we have been able to give you a little clearer understanding of our mutual problems, and that from this discussion you may have derived some benefit. Personally, it has been a pleasure for me to meet with you, and it will always be my pleasure to be of service to any or all of you.

Children Should be Warned Against Playing with Blasting Caps

EACH year there are numbers of children, under the age of sixteen, who are injured, and in some instances, killed, from playing with blasting caps.

These accidents have been a matter of great concern to companies manufacturing commercial explosives, and for many years numbers of these companies carried on campaigns of warning against such accidents.

In 1926 the Institute of Makers of Explosives, a trade association comprising manufacturers of commercial explosives, took the matter up and began a vigorous movement to arouse public sentiment in the hope that parents, teachers, and all others who had children in their care, would cooperate in safeguarding boys and girls by instructing them concerning the dangers of playing with blasting caps.

Warnings against allowing these blasting caps to fall into the hands of children had for years been given to all purchasers of such blasting accessories. Increased efforts along this line were made in 1926, and new literature placed in each box of caps, together with the wording on the boxes containing the caps, specifically called attention to the dangers. These efforts have been continued each year.

Reports show that the most common types of accidents are from striking the caps with a hammer or stone. Any blasting cap will explode if it is hit hard enough with such instruments. Accidents are caused in large measure also by holding lighted matches to the caps. Picking out the explosive with a pin or nail also causes many injuries.

Blasting caps are detonators used for firing high explosives. They are loaded with a very sensitive and powerful explosive. One type is a small metal cylinder closed at one end and usually made of copper, although other metals are also used. This type is designed to be exploded by sparks from a fuse. Another type is known as an Electric Blasting Cap. This is also a metallic cylinder which may vary in dimensions and color. This type always has wires attached, sealed in with sulfur, rubber, or similar materials. A very small amount of current, even that supplied by an ordinary flash light battery, is sufficient to explode a single cap. Therefore, the wires from an Electric Blasting Cap may not be connected to a source of current without the danger of exploding the cap. Both types are also sensitive to impact with a hammer or stone and to fire applied to the metal cylinder.

These detonators are necessary in the use of dynamite. The caps get into the hands of children through the carelessness of users. Workmen leave them around following blasting operations. Sometimes they are carried home by workers and left about where children can find them.

The movement to prevent accidents to children from playing with blasting caps is an attempt to completely avoid such accidents and to save boys and girls for useful work in later life.

Most of the accidents occur in rural districts or in the suburbs of the larger cities.

Children and others inexperienced with explosives should not touch a blasting cap. It should be allowed to remain where found until an officer of the law or other responsible adult can be located.

Two Important Highway Birthdays—The Gas Tax and Pneumatic Tire

TWO February birthdays held particular significance for highway users. The gasoline tax was 21 years old on Feb. 25th and the levy, first imposed by an Oregon legislature, now prevails in all states. The initial rate of one cent per gallon has been increased in Oregon to five cents. The gas tax varies from two cents in Missouri and the District of Columbia to seven cents in Florida, Louisiana and Tennessee.

Thirteen years after Oregon introduced the gas tax law, the Federal government inaugurated a duplicating tax on gasoline, and this tax, termed a temporary levy when adopted by Congress, is still being collected.

The other birthday marked an equally important milestone. One hundred years ago Feb. 5th, John Boyd Dunlop, inventor of the pneumatic tire, was born in an Ayrshire cottage. Fifty-two years later in Belfast he devised a rubber tube for his son's tricycle, a home-made affair that led to the development of the bicycle tire and the automobile tire.

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